

WHAT IS CLAIMED IS:

1. A plasma processing method for processing a surface of an object to be processed made of a metal or a semiconductor by applying activated particles generated by a microplasma generated at a pressure of not lower than 10,000 Pa and not higher than three atmospheric pressures to the surface of the object, the method comprising:

removing a natural oxide film on the surface of the object; and

etching a part or whole of a region in which the natural oxide film has been removed.

2. The plasma processing method as claimed in claim 1, wherein

the microplasma is generated by supplying an electric power to an electrode provided at a microplasma source arranged in a neighborhood of the object or the object while supplying gas to the microplasma source when carrying out the film removing and the region processing, and the generated activated particles are made to act on the object so as to process the surface of the object,

the natural oxide film is removed by applying the activated particles to a first portion of the surface of the object in the film removing, and

an etching is carried out by applying activated particles to a second portion that is included in the first

portion of the surface of the object and is narrower than the first portion in the region processing.

3. The plasma processing method as claimed in claim 2, wherein

5 with the microplasma source having an inner gas outlet and an outer gas outlet,

gas mainly comprised of inert gas is issued from the inner gas outlet and gas mainly comprised of inert gas is issued from the outer gas outlet in applying the
10 activated particles to the first portion, and

gas mainly comprised of inert gas is issued from the inner gas outlet and gas mainly comprised of reactive gas is issued from the outer gas outlet in applying the activated particles to the second portion.

15 4. The plasma processing method as claimed in claim 2, wherein

with the microplasma source having an inner gas outlet and an outer gas outlet,

gas mainly comprised of inert gas is issued from
20 the inner gas outlet and no gas is issued from the outer gas outlet in applying the activated particles to the first portion, and

gas mainly comprised of inert gas is issued from the inner gas outlet and gas mainly comprised of reactive
25 gas is issued from the outer gas outlet in applying the

activated particles to the second portion.

5. The plasma processing method as claimed in claim 2, wherein

with the microplasma source having an inner gas
5 outlet and an outer gas outlet,

gas mainly comprised of inert gas is issued from
the inner gas outlet and gas mainly comprised of reactive
gas is issued from the outer gas outlet in applying the
activated particles to the first portion, and
10 gas mainly comprised of inert gas is issued from
the inner gas outlet and gas mainly comprised of reactive
gas is issued from the outer gas outlet in applying the
activated particles to the second portion by a quantity
several times to several tens of times larger than in
15 applying the activated particles to the first portion.

6. The plasma processing method as claimed in claim 1, wherein

the microplasma is generated by supplying an
electric power to an electrode provided at a microplasma
20 source arranged in a neighborhood of the object or the
object while supplying gas to the microplasma source when
carrying out the film removing and the region processing,
and the generated activated particles are made act on the
object so as to process the surface of the object,

25 the natural oxide film is removed by applying

activated particles that have reducibility, to the surface of the object in the film removing, and

an etching is carried out by applying in the region processing activated particles that have etchability, to the surface of the object to which the activated particles that have reducibility have been applied, in the region processing.

7. The plasma processing method as claimed in claim 6, wherein

the activated particles are applied to the first portion of the surface of the object in the film removing, and

the activated particles are applied to a second portion that is included in the first portion and is narrower than the first portion in the region processing.

8. The plasma processing method as claimed in claim 7, wherein

with the microplasma source having an inner gas outlet and an outer gas outlet,

gas mainly comprised of inert gas is issued from the inner gas outlet and gas mainly comprised of inert gas is issued from the outer gas outlet while reducing gas is mixed with the gas issued from the inner gas outlet or the outer gas outlet, in applying the activated particles to the first portion, and

gas mainly comprised of inert gas is issued from the inner gas outlet and gas mainly comprised of etching gas is issued from the outer gas outlet in applying the activated particles to the second portion.

5 9. The plasma processing method as claimed in claim 7, wherein

 with the microplasma source having an inner gas outlet and an outer gas outlet,

 a mixed gas of inert gas and reducing gas is
10 issued from the inner gas outlet and no gas is issued from the outer gas outlet in applying the activated particles to the first portion, and

 gas mainly comprised of inert gas is issued from the inner gas outlet and gas mainly comprised of etching
15 gas is issued from the outer gas outlet in applying the activated particles to the second portion.

 10. The plasma processing method as claimed in claim 7, wherein

 with the microplasma source having an inner gas
20 outlet and an outer gas outlet,

 a mixed gas of inert gas and reducing gas is issued from the inner gas outlet and gas mainly comprised of etching gas is issued from the outer gas outlet in applying the activated particles to the first portion, and

25 gas mainly comprised of inert gas is issued from

the inner gas outlet, and gas mainly comprised of etching gas is issued from the outer gas outlet by a quantity larger than in applying the activated particles to the first portion, in applying the activated particles to the
5 second portion.

11. The plasma processing method as claimed in claim 1, wherein

the microplasma is generated by supplying an electric power to an electrode provided at a microplasma
10 source arranged in a neighborhood of the object or the object while supplying gas to the microplasma source when carrying out the film removing and the region processing and making the generated activated particles act on the object so as to process the surface of the object, the
15 method comprising:

the natural oxide film on the surface of the object is removed by supplying a first electric power to the electrode provided at the microplasma source or the object in the film removing; and

20 the part or whole of the region in which the natural oxide film on the surface of the object has been removed is etched by supplying a second electric power that is greater than the first electric power to the electrode provided at the microplasma source or the object in the
25 region processing.